Utilization of Ceramic Waste in Concrete

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***Abstract*- Due to scarcity of the construction materials, it is need to explore alternative construction materials. Hence many efforts are being made for the use of different types of waste and by-products from industrial as well as household waste and recyclable materials in the production of various construction materials. In the construction field ceramic tiles are used as building material. While manufacturing the ceramic tiles about 10-25% production goes as waste. This waste from the ceramic industries dumped at nearby places. But it can be recycled and can be used as a construction material. Hence using of ceramic waste in concrete would be beneficial. This study is carried out on M25 grade of concrete. In this study coarse aggregate has been partially replaced by ceramic tiles in the proportion of 0%, 10%, 15%, 20% and 25% by weight to evaluate the various properties like compressive strength, split tensile strength, durability for different concrete mixes after 7, 14 and 28 days curing period. These properties of concrete were examined and compared with normal concrete.**

Index Terms- Ceramic tiles, Compressive strength, Durability, Industrial waste, Split tensile strength.

I. INTRODUCTION

Concrete is the most widely used man-made construction material all around the world. It is a composite material of water, sand, aggregate, and cement. In every construction aspects concrete is require, hence concrete plays an important role in present scenario of construction industries. The strength of the concrete is based on the strength of different ingredients used in the preparation of concrete. This study is carried out on M25 grade of concrete. The demand of construction materials is increasing day by day. Therefore, there is a need to discover alternative building materials from industrial waste, construction waste, agricultural waste that can be recycled. In the construction field ceramic tiles are used as building material. While manufacturing the ceramic tiles about 10-25% production goes as waste. This crushed ceramic waste from the ceramic industries dumped at nearby places after defined as useless resulting in pollution. But it can be recycled and can be reused as a construction material in concrete. In present world which is seeking for alternative construction materials which are environment friendly, economical as well as provides same quality as that of a normal aggregate made of natural coarse aggregates. Ceramic waste can be used safely with no need for change in production and application process.

II. EXPERIMENTAL MATERIALS

A. Materials

a) Ceramic waste:-

Ceramic tiles can be used in concrete to improve its strength and other durability factors. Crushed tiles are replaced in place of coarse aggregate by the percentage of 20%. Broken tiles were collected from the solid waste of ceramic manufacturing unit and from demolished building. The waste tiles were crushed into small pieces by manually or by using crusher. The required size of crushed tile aggregate was separated to use them as partial replacement to the natural coarse aggregate.

b) Cement:-

Ordinary Portland Cement (OPC) confirming to IS-269 (53 Grade) was used for the experimental work.

c) Coarse aggregate:-

The aggregate exclusively passing through 20 mm sieve size and retained on 4.75 mm sieve is selected. It shall be hard, durable and dense. It should be clean and free from dust or dirt. It should not absorb water more than 10% of their weight because more absorption of water creates pores.

d) Fine aggregate:-

The aggregate most of which pass through 4.75 mm IS sieve are termed as fine aggregate. It should be clean and free from dust or dirt. Sea sand shall not be used. River sand locally available in the market was used in the investigation. The sand was surface dried before use.

e) Water:-

Water used shall be clean and reasonably free from oils, acids and salts. Generally, water that is suitable for drinking is satisfactory for use in concrete. The potable water is generally considered satisfactory for use in concrete.

f) Admixture- PermaPlast PC-100:-

PC 100 is water reducing admixture design for the production of block industry. It can reduce the material cost by reduction in cement concrete without loss in strength.

III. DESIGN MIX

Proportion:-

The proportion of the material shall be 1:1:2 i.e., 1 part of cement, 1 part of fine aggregate, and 2 part of coarse aggregate.

Table I: Design mix proportion for various concrete

Concrete	% replacement
M0	0% replacement
M1	10% replacement
M2	15% replacement
M3	20% replacement
M4	25% replacement

Table II: Concrete design mix proportion

Material	M0	M1	M2	M3	M4
Cement	1.107	1.107	1.107	1.107	1.107
C.A	3.965	3.569	3.370	3.172	2.974
F.A	2.895	2.895	2.895	2.895	2.895
Water	0.499	0.499	0.499	0.499	0.499
C.T	-	0.396	0.594	0.793	0.991
Admixture	0.007	0.007	0.007	0.007	0.007

C.A= Coarse Aggregate, F.A= Fine Aggregate, C.T= Ceramic Tiles

IV.EXPERIMENTAL METHODOLOGY

A. Compressive Strength:

Compressive strength tests were performed on compression testing machine using cube samples. The comparative studies were made on their characteristics for concrete mix with partial replacement of coarse aggregate with Ceramic waste as 10%, 15%, 20% and 25%.. Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 150 x 150 x 150 mm cube with proper compaction, after 24 hours place the specimen in water for curing.

Table III: Compressive strength at 7, 14 and 28 days

Concrete type	Average compressive strength (MPa)		
	7 days	14 days	28 days
M0	24.44	30.62	34.25
M1	24.90	31.52	34.90
M2	25.15	32.36	35.20
M3	24.19	31.03	34.11
M4	23.55	30.15	33.08

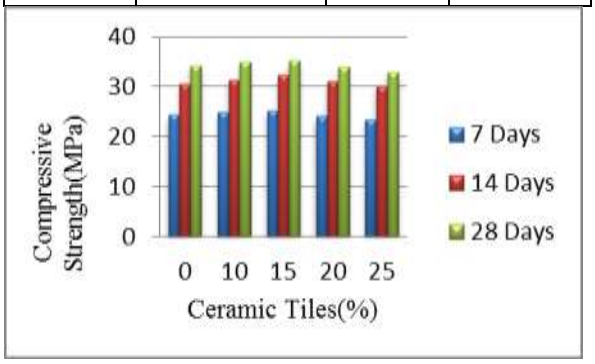

Fig 1: Average compressive strength

B. Split tensile strength:

It is an indirect method of applying tension in the form of splitting and finding the tensile strength of concrete.The cylindrical specimen is tested for M25 grade of concrete. The cylinder of size 150mm diameter x 300mm height was tested for split tensile strength. The specimen is tested after a curing period of 7, 14 and 28 days for split tensile strength. To improving the split tensile strength adding various percentages of ceramic tiles as replacement of coarse aggregate and the results are obtained. All the mixes designed for various replacements such as 0%, 10%, 15%, 20% and 25%. Results are compared with conventional concrete.

The splitting tensile strength is calculated using the formula,

$$fct = 2P/\pi lD$$

Where,

P = Maximum load in newtons applied to the specimen

L = length of the specimen in mm

D = diameter of the specimen in mm

Table IV: Split Tensile Strength at 7, 14 and 28 days

Concrete type	Average tensile strength (MPa)		
	7 days	14 days	28 days
M0	1.71	2.39	2.88
M1	1.83	2.45	3.27
M2	2.08	2.67	3.51
M3	1.79	2.51	3.02
M4	1.68	2.24	2.84

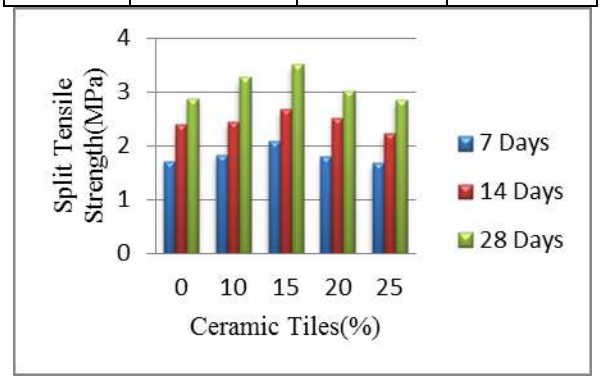

Fig 2: Average tensile strength

C. Durability:

Concrete structures are meant to last a "lifetime". Most concrete structures have a design life of 50 or 100 years. But unfortunately we are finding that many of today's structures are not living up to expectations. The premature deterioration of concrete infrastructure is one of the great hidden costs of our time. So what is the cause of this lack of durability? It is rightly said that everything bad that happens to concrete happens as a result of water. Water carries chemical contaminants into the concrete; it can erode the surface, corrode the steel reinforcement, and contribute to expansive and disruptive reactions and more. Concrete durability is defined as the concrete ability to resist weathering actions and chemical attack while maintaining its desired engineering properties.

The cubes were cast and kept for 24 hours. After 24 hours the cubes were removed from the mould and weighed accurately. The cubes were immersed in chemical water containing MgSO4 and sea water for 90 and 120 days until they were taken out for testing. The specimens were weighed again and the weight difference before and after curing was determined. After that specimens were taken for compressive testing to measure their strength loss due to chemical attack.

Table V: durability strength at 90 and 120 days (sea water)

Concrete type	Average strength(MPa)		Average Weight(kg)			
			90 days		120 days	
	90 days	120 days	Before curing	After curing	Before curing	After curing
M0	32.24	31.77	9.964	8.210	9.711	7.981
M1	32.73	32.27	10.263	8.315	10.975	8.234
M3	33.15	32.83	10.419	8.587	10.226	8.356

Table VI: Durability strength at 90 and 120 days (MgSO4 water)

Concrete type	Average strength(MPa)		Average Weight(kg)			
			90 days		120 days	
	90 days	120 days	Before curing	After curing	Before curing	After curing
M0	31.32	30.51	9.775	7.969	9.616	7.976
M1	31.81	31.38	9.863	8.153	9.717	8.087
M3	32.37	31.87	10.428	8.308	10.209	8.253

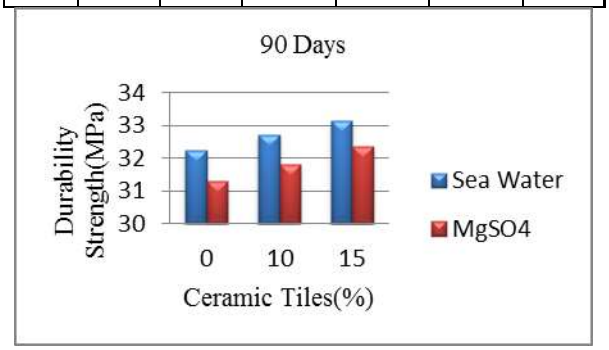

Fig 3: Durability strength for 90 days

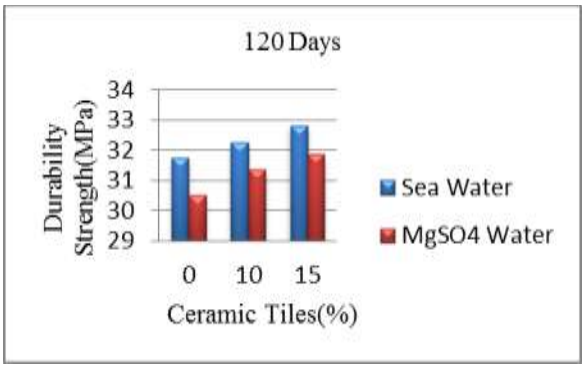

Fig 4: Durability strength for 120 days

VI. CONCLUSION

- The compressive strength of M25 grade concrete increase when the replacement of coarse aggregate with ceramic tile aggregate up to 15% replace by weight of coarse aggregate and further replacement of coarse aggregate with ceramic tiles decrease the compressive strength.

The maximum increase in compressive strength is found up to 25.15 MPa at 7 days, 32.36 MPa at 14 days and 35.20 MPa at 28 days of curing period. Beyond 15% of replacement by coarse aggregate strength starts to decrease.

- Concrete on 15% replacement of coarse aggregate with ceramic tiles, compressive strength obtained more and the cost of concrete is reduced, hence it is more economical without compromising concrete strength.
- Utilization of ceramic waste and its application are used for the development of the construction industry.
- It is the possible alternative solution of safe disposal of ceramic waste.
- The split tensile strength of M25 grade concrete increases when the coarse aggregate is replaced with ceramic tile waste up to 15% and further replacement of coarse aggregate with ceramic waste decreases the strength gradually.
- Ceramic waste concrete has increased durability performance.

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